SPACE FOR MANKIND'S BENEFIT

A Congress to be presented by the Huntsville Association of Technical Societies. Topics covered include TV satellite systems, data management for earth resources, laser communications, biotelemetry, medical technology and biotechnology. Date: November 15-19, 1971. For further information, contact HATS, P.O. Box 1266, Huntsville, Alabama.

TRAINING PROGRAM IN PROSTHETICS, ORTHOTICS AND SENSORY AIDS

To be conducted by the Prosthetic and Sensory Aids Service of the Veterans Administration in San Juan, Puerto Rico. There is no registration fee; registration is limited and applications will be accepted on a first-come, first-served basis. Date: November 1-5, 1971. For further information, contact Mr. William M. Bernstock, Asst. Chief, Research and Development Division, Prosthetic and Sensory Aids Service, Veterans Administration, 252 Seventh Avenue, New York New York 10001.

AVIATION RESEARCH MONOGRAPHS

Previously unpublished reports of historical significance, timely edited proceedings of important scientific events, outstanding theses and dissertations from any academic discipline relevant to aviation, and original reviews of interdisciplinary research problems. The first two issues will be available in mid-summer; the third will be published in the early fall. For further information or orders, contact Engineering Publications, 112 Engineering Hall, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801.

INDUSTRIAL PSYCHOLOGIST

M.S. Industrial Psychologist with three or more years of experience, including some research.

Some background and training in:

- Industrial Safety
- Industrial Training
- Safety Regulations and Requirements

Must have interest in pursuing research in these areas.

AN EQUAL OPPORTUNITY EMPLOYER

All inquiries kept in strict confidence.

Send resume to:

W. W. Spievak
Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

The Human Engineering of the Typewriter Keyboard: A Case in Point

The following article is from a paper submitted by Sue Ann Phillips for a course in Human Factors at Georgia Southern College, Statesboro, Georgia. Her Instructor, J. Peter Kincaid of HFS, has condensed her material into a form suitable for publication here.

The typewriter is an instrument that is essential to today's modern business world. Its keyboard is so familiar to today's typists that it would be folly to change it. None-the-less the arrangement of the keyboard is not conducive to efficient typing. If a human factors analysis had been done before the present keyboard arrangement had become standard, today's millions of typists might be less taxed. This paper reviews what is wrong with present keyboard arrangement and how the problem evolved. It represents a situation that can be avoided with other equipment through the application of good human engineering principles **before** design becomes standard.

In 1872, after countless improvements in the typewriter mechanism, the original arrangement of letters on the keyboard was changed by Sholes and another pioneer, Densmore, from one according to the letters of the alphabet to one of greater convenience (Russon and Wanous, 1960). There had been two things wrong with having the keys in alphabetical order. First, the most often used letters were not necessarily the most accessible, and, second, some of these letters were so close together that the type bars, hung as they were in a circular "basket," collided more frequently than need be (Current, 1954).

Sholes had not devised the most efficient of all possible keyboard arrangements. He could have done a better job if he had first made a careful study of finger movements and the frequency of occurrency of letters and letter combinations. Still, the new keyboard was a great improvement over the old one. Even that early in typewriter history any alteration was difficult, because in selling the machines it was better to have them all alike (Current, 1954).

There were still vestiges of the alphabetical order keyboard in the original Sholes keyboard, which was arranged in 1873. The "fghjkl," for example, across the middle row, was not so far out of place, as seen below in Figure 1.

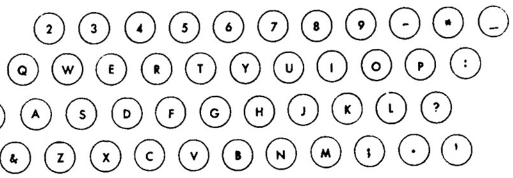

Fig. 1. The original Sholes keyboard, 1873. Redrawn from Jones (1956), page 38.

The "Universal" keyboard, with dual shift, positioned three type on each typebar and used on shift key for capital letters and another for numerals and characters, provided the stiffest competition to the four-bank "original" keyboard. For a period of over 40 years, from 1881 until 1924, the competition continued. The "Universal" keyboard is shown in figure 2.

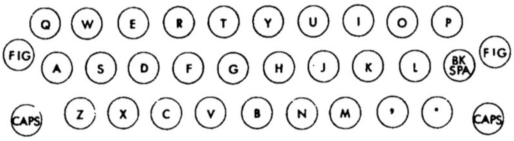

Fig. 2. The universal keyboard, 1879-1924. Redrawn from Jones (1956), page 38.

Russon and Wanous (1960) suggest that the universal keyboard is far from perfect. They review evidence that the left hand is required to do more work than the right, that some of the weak fingers do more work than the strong ones, that many common words must be typed entirely by one hand or the other, and that many long or awkward reaches must be made because of the way certain of the letters are paired in common sequences.

Another serious shortcoming of the universal keyboard arises from the fact that reaches to the third row of keys are far more frequent than the stroking of keys on the home row, a condition which results in many inefficient and awkward hand and finger motions. The statistics: Third Row – 52% of stroking; Home Row – 32% of stroking; Bottom Row – 16% of stroking (Russon and Wanous, 1960). It seems very evident that the universal keyboard is not very efficient. The same follows for the "standard" keyboard typewriter we use today which is illustrated in figure 3.

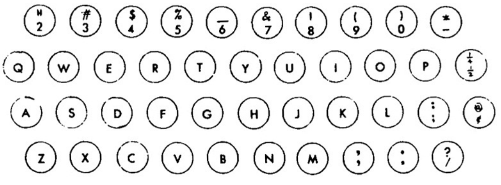

Fig. 3. The standard keyboard, currently used. Redrawn from Jones (1956), p. 40.

Judged from the standpoint of the touch typist, the arrangement of the alphabet is madly inconvenient. In the first place it is left-handed. Most typists are right-handed, and their right hands are more agile than their left. But the standard order, sometimes called the "qwerty uiop," gives the left hand 56 percent of the total number of strokes. It also gives weak fingers, particularly the little finger of the left hand, too much work, including the two toughest keys, the shift-lock and the backspacer. In the third place it demands an entirely unnecessary amount of awkward reaching because it ignores the frequency with which the letters of the alphabet are encountered, which is, in order: E T A O S I N R H L D C U M Y B P W F G V K J X Q Z, according to Bliven (1954). It should bunch the most common, of course. A rational keyboard would try to make the most of what's easiest, which is hitting a letter with one hand and the next with the other hand. A word like "federated," for instance, is a terror. On the "qwerty uiop" keyboard, the left hand does it all; the right hand runs some danger of muscular atrophy while it waits for the left hand to finish. Whereas a word like "sicken" is a cinch, for it employs first the left and then the right and then the left again. Forty-eight per cent of all finger motions on the standard keyboard are one-handed, the hard way. On a sensible keyboard they shouldn't amount to more than 33 per cent according to Bliven (1954).

Among one-handed motions, hurdles – in which the finger has to jump a key to get from here to there – are the most difficult. It's bad enough to move from "f" to "r", but it's worse to jump from "v" to "r" over the top of "f". The hurdle from "z" to "q" with the little finger of the left hand is the worst of all, but fortunately it almost never comes up. Two words such as "minimum" and "pumpkin" keep the right hand jumping wildly. On the standard keyboard 11 per cent of all motions are hurdles. They could be cut to one per cent according to Bliven (1954).

Almost any reasonable man, upon realizing that the typewriter keyboard is silly, would ask, "Why doesn't somebody do something about it?" He might even nominate himself as a reformer, thinking that a machine with a superior key arrangement ought to make money. Before anyone invests his money in a keyboard-reform scheme, he must consider the sad fact that if the public would buy it, the major business machine companies would be selling it. Mechanically speaking, any of the typewriter firms could arrange the keys in any order quite easily. However, they cannot rearrange the standard keyboard because millions of buyers know how to typewrite by touch on it and don't want to learn a different system. Actually, with a strange keyboard even an experienced typist would have to "unlearn" as well as learn. This is why; despite the best efforts of a long line of keyboard reformers, the plan of 1872 remained essentially unchanged to become the "universal" keyboard of later generations.

For all these reasons, it seems likely that the standard typewriter keyboard will remain, for the most part, unchanged, in spite of its poor human engineering design. It remains a case in point which illustrates a sad fact known by human engineers everywhere: an ounce of human engineering prevention is worth a pound of human engineering cure.

REFERENCES

Bliven, Bruce, Jr. **The Wonderful Writing Machine.** New York: Random House, 1954.

Current, Richard N. **The Typewriter and the Men Who Made It.** Urbana: The University of Illinois Print Shop, 1954.

Gannett, Lewis. Book Review. **The New York Herald tribune.** May 14, 1954.

Jones, C. LeRoy. **Typewriters Unlimited.** Springfield, Missouri: Rocky's Technical Publications, 1956.

Russon, Allien R. and Wanous, S. J. **Philosophy and Psychology of Teaching Typewriting.** Cincinnati: Southwestern Publishing Company, 1960.